

# MOBILE COMPUTING

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CSE-4225



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# Course Goals

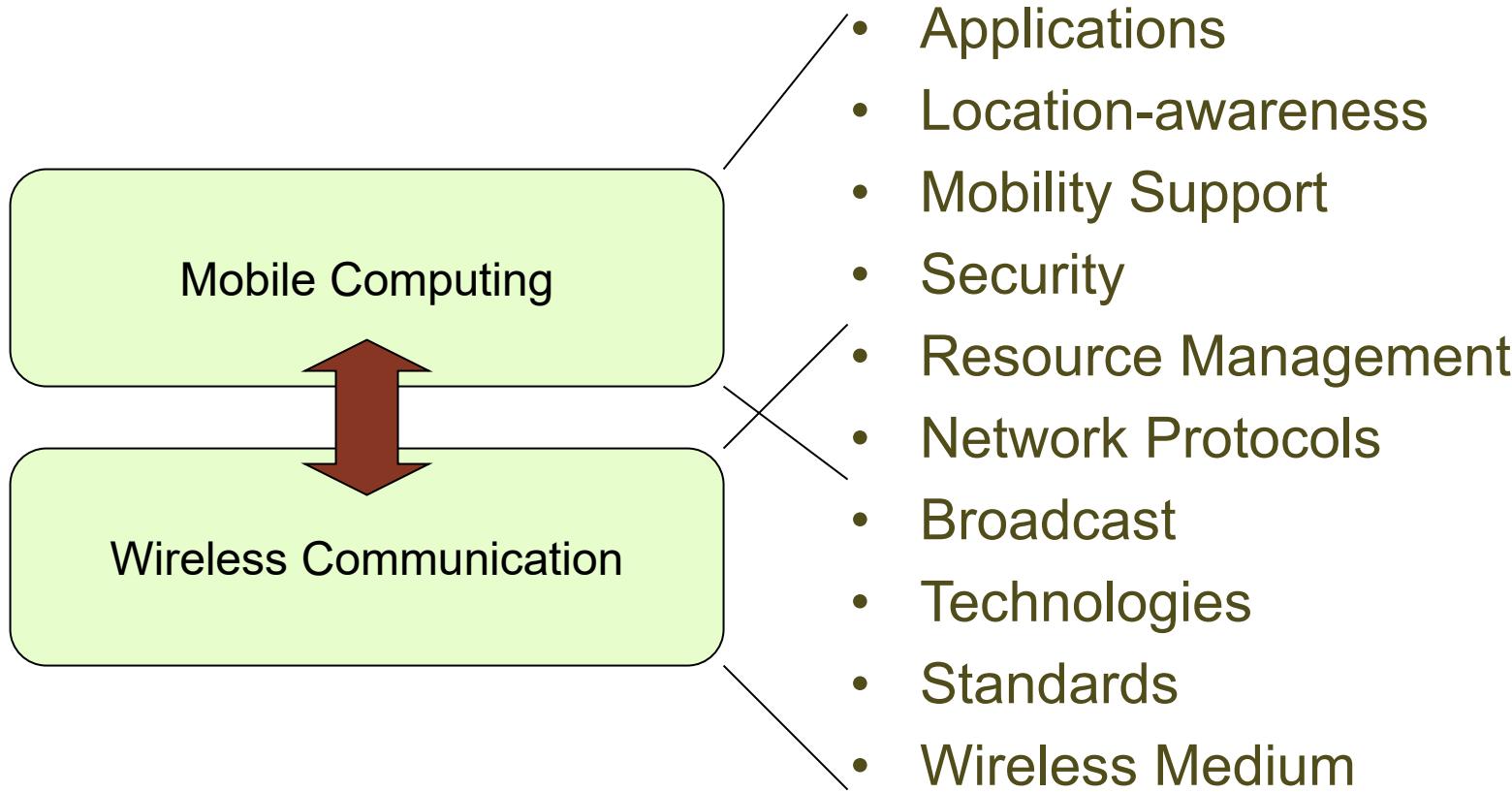
- Fundamentals of mobile computing
- Fundamentals of wireless networking
- Topics from closely related areas:
  - Pervasive Computing
  - Wearables
  - Internet of Things
  - Real-Time Systems
  - Embedded Systems
  - Wireless sensor networks
- Acquire and practice development skills

# Mobile Computing (MC)



- Umbrella term used to describe technologies that enable people to access services **anytime** and **anywhere**
- Allows transmission of **data, voice and video** via a **computer or any other wireless enabled device** without having to be connected to a fixed physical link
- Main concept involves
  - Mobile Communication
  - Mobile Hardware
  - Mobile Software

# Mobile Computing



# Wired vs Wireless

## • **Wired Networks**

- high bandwidth
- low bandwidth variability
- can listen on wire
- high power machines
- high resource machines
- need physical access (security)
- low delay
- connected operation

## • **Mobile Networks**

- low bandwidth
- high bandwidth variability
- hidden terminal problem
- low power machines
- low resource machines
- need proximity
- higher delay
- disconnected operation

# Main Concept: Mobile Comm.

- Refers infrastructure to ensure seamless and reliable communication
- Protocols, services, bandwidth, and portals
- No collision with other existing systems (as well as same service)

# Main Concept: Mobile H/W

- Includes mobile devices or device components that receive or access the service of mobility
- Capable of sensing and receiving signals
- Capable of sending and receiving signals at the same time
  - Which transmission mode?
- Example
  - portable laptops, smartphones, tablet PCs, Personal Digital Assistants

# Main Concept: Mobile S/W



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# Mobile Computing: Aspects

- **User Mobility**

- Users communicate “anytime, anywhere, with anyone”
- Example: read/write email on web browser

- **Device Portability**

- Can be connected anytime, anywhere to the network ( using different mechanisms)

- **Communication Device Characteristics**

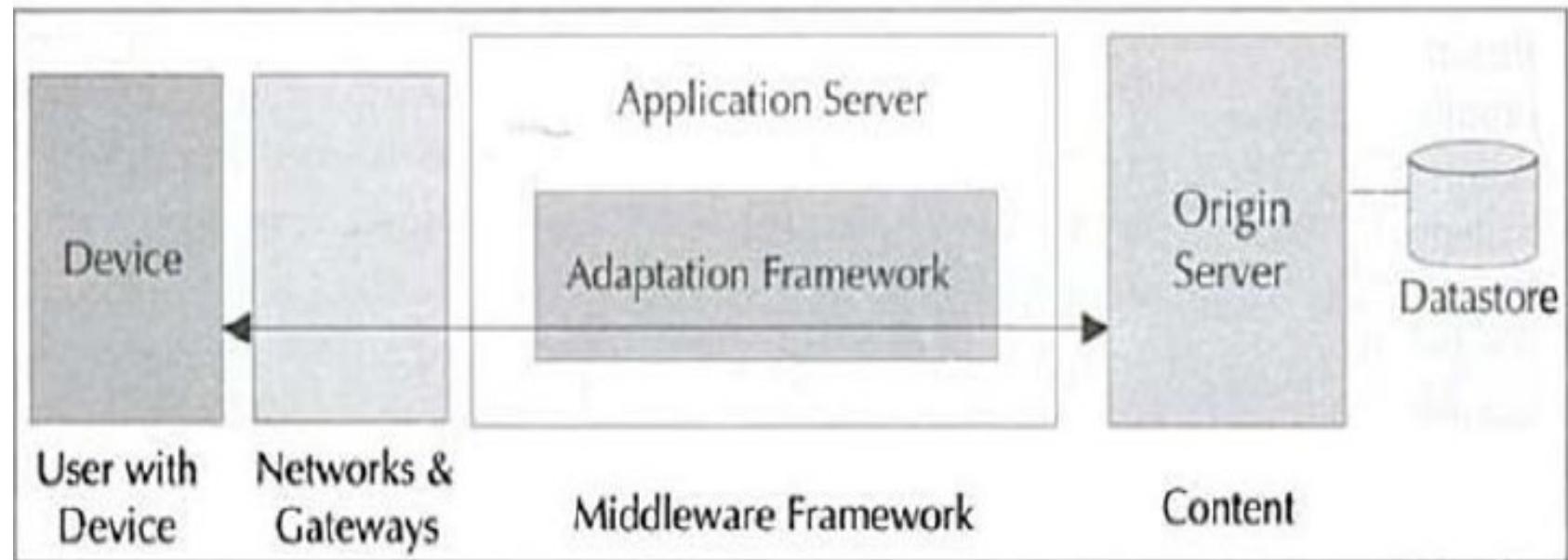
- Fixed and wired
- Mobile and wired
- Fixed and wireless
- Mobile and wireless (most interesting)
  - Most successful: GSM with more than 800 million users

# Mobile Computing: Functions

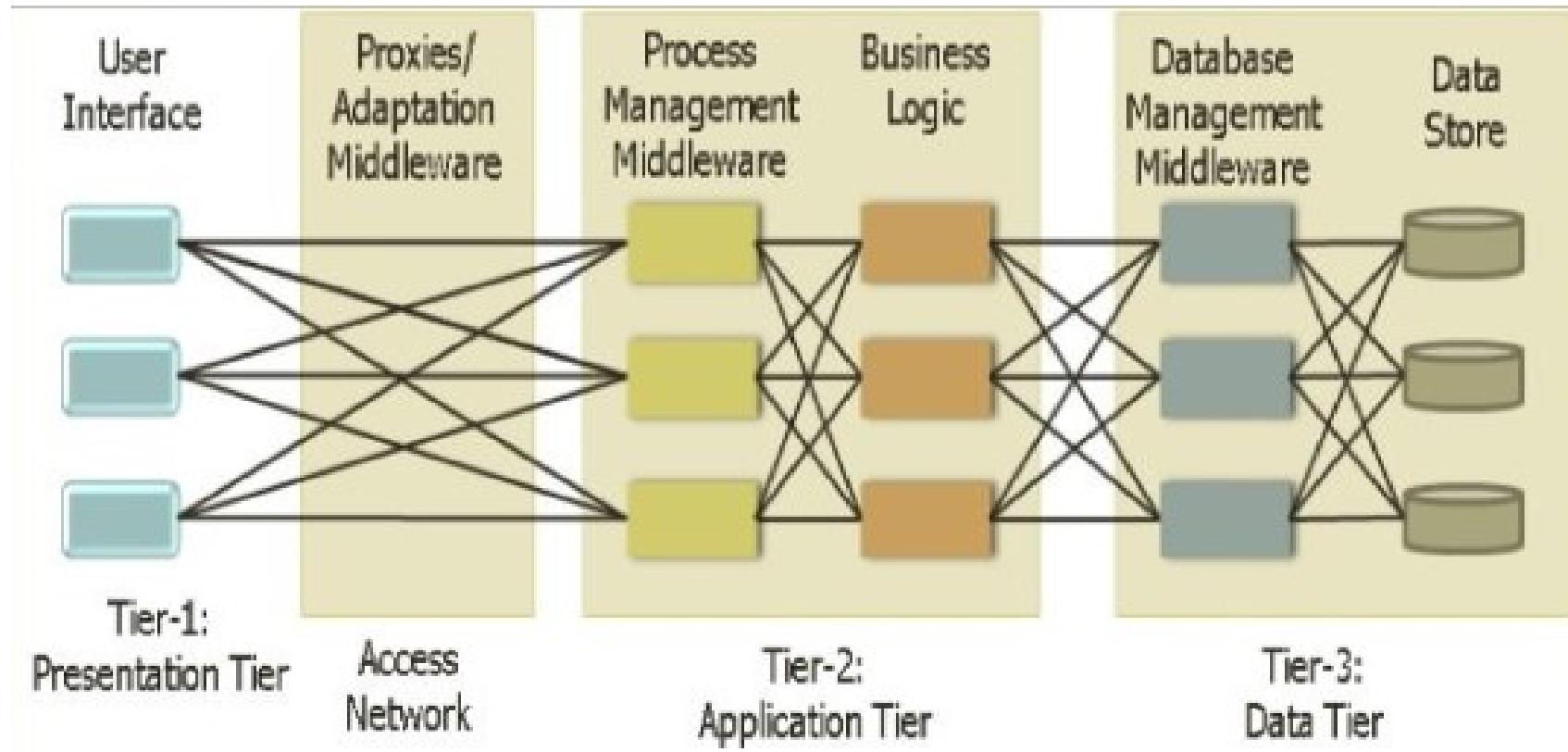
- **User Mobility**
- **Device Mobility**
- **Network Mobility**
  - Able to move from one network to another network (can be another country)
- **Bearer Mobility**
  - Allows a device to change bearers (WLAN, 3G, GPRS) without interruption to the user's data sessions
- **Session Mobility**
  - Able to move from one user-agent (acting on behalf of a user, such as a web browser) environment to another
- **Service Mobility**
  - Able to move from one service to another
- **Host Mobility**
  - Either a client or server

# Logical Functions of MC

- **User with device**
- **Network**
- **Gateways**
- **Middleware**
- **Contents**



# Mobile Computing: Architecture



# Mobile Computing: Architecture

- **Presentation Layer (UI)**

- Presents data to the user
- Permits data manipulation and data entry
- Requests the data from Business layer
- Accomplished through use of Dynamic HTML and client-side data sources and data cursors

# Mobile Computing: Architecture

- **Business Logic Layer**

- Acts as the server for client requests from workstations according to Business rules fetch or insert data through the Data Layer
- Determines what data is needed (and where it is located) and acts as a client in relation to a third tier of programming that might be located on a local or mainframe computer
- As not tied to a specific client, it can be used by all applications and can be moved to different locations, as response time and other rules require

# Mobile Computing: Architecture

- **Data Access Layer**

- Made up of the DBMS that provides all the data for the above two layers.
- Avoiding dependencies on the storage mechanisms
  - Allows for **updates or changes** without the application tier clients being affected by or even aware of the change

# Mobile Computing: Applications

- **Vehicles**
- **Emergencies**
- **Business**
- **Credit Card Verification**
- **Infotainment**
  - Broadcast material that is intended both to entertain and to inform
- Where not?

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# Mobile Computing: Limitations

- Resource constraints: Battery
- Interference
- Bandwidth
- Dynamic changes in communication environment
- Network Issues
- Interoperability issues
  - varying protocol standards
- Security constraints

# Example: Smartphone

- **Portability:** carry it anywhere you want
- **Miniaturization:** make it possible to build device to fit in your pocket
- **Connectivity:** Wi-Fi, LTE/4G, cellular, Bluetooth
- **Convergence:** phone, camera, gaming device, movie streaming, music player, ...
- **Divergence:** ?
- **Applications:** “Rise of the Apps”
- **Digital Ecosystem:** social networks, distributed gaming, video streaming, work apps, ...

# App Store (iOS)

- 2003: iTunes Music Store
- 2008: iPhone App Store (iPhone 3G with App Store support)
- 2015: > 100 billion app downloads
- 2016: > 2 million apps
- 2016: China biggest App Store market
- 2016: App developers earned \$20 billions
- Most downloaded app: Minecraft Pocket Edition (paid) and Pokemon GO (free)

# Trends in Mobile: Phone Subscribers

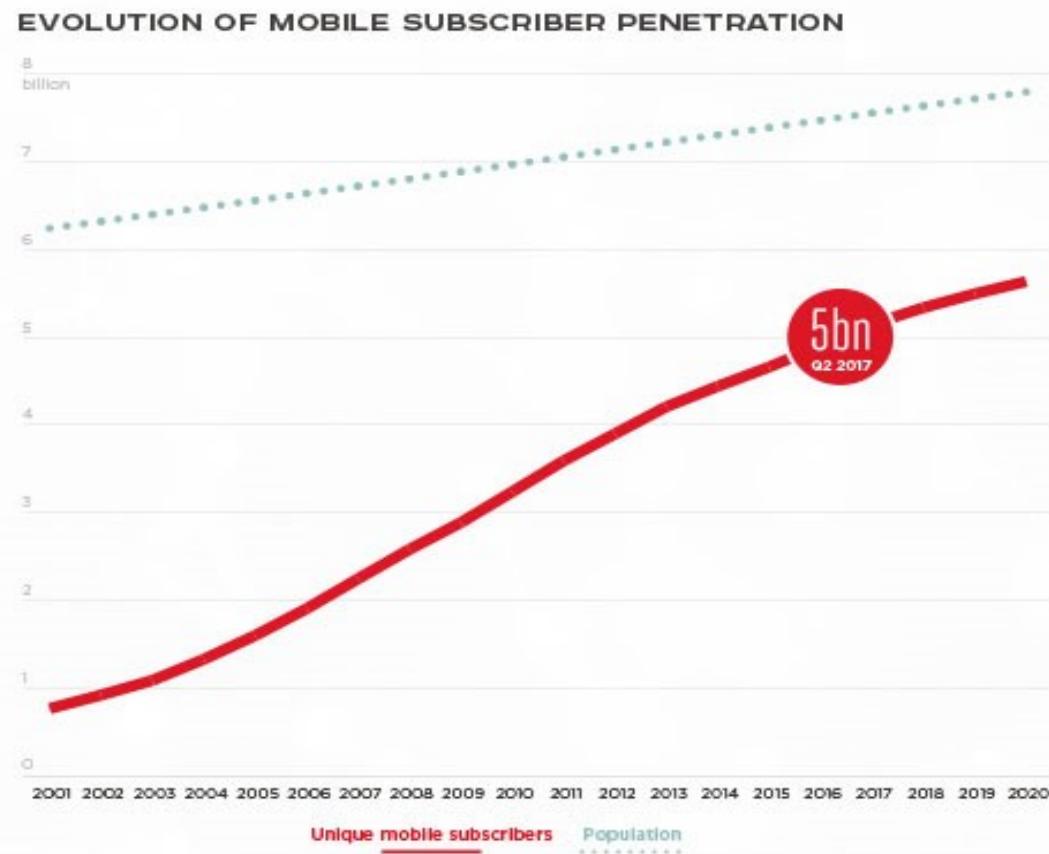


## 1 5 billion people now use mobile – the highest scale consumer tech worldwide

Key takeaways 4

Two thirds of the global population are now mobile subscribers; mobile has a greater reach than any other technology.

However, the rate of growth is slowing. It took four years to move from 4 billion to 5 billion; reaching 6 billion will take longer still.



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# Trends in Mobile: Shopping



In stores, **82% of smartphone users** turn to their devices to help them **make a product decision**.

SOURCE: Google/Ipsos, "Consumers in the Micro-Moment" study, March 2015, United States. [ThinkwithGoogle.com](http://ThinkwithGoogle.com)

**91%** growth in B2B researchers using smartphones throughout the path to purchase



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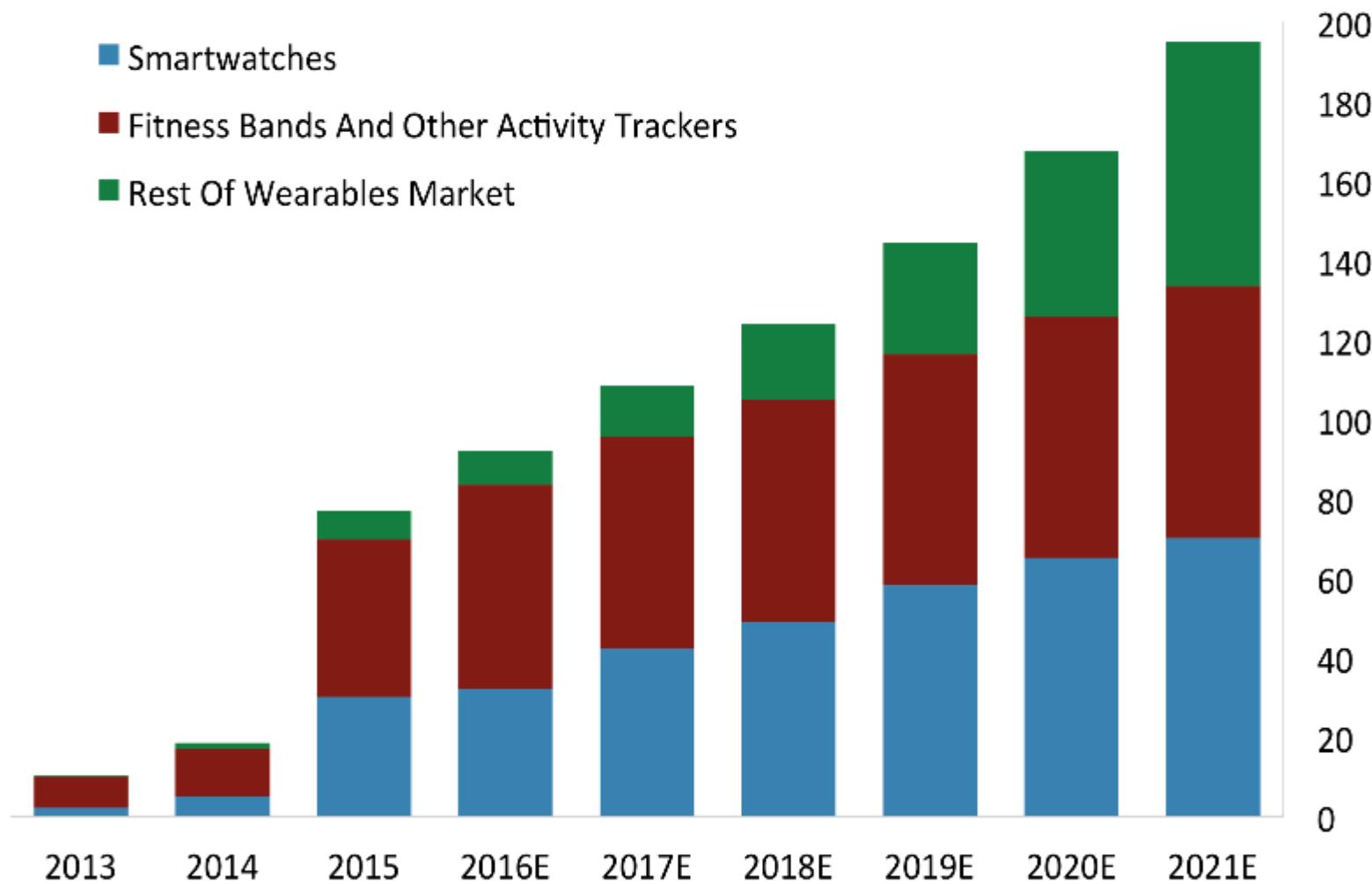
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# Global Wearables Shipment Forecast, By Device

Millions



Source: IDC, BI Intelligence estimators

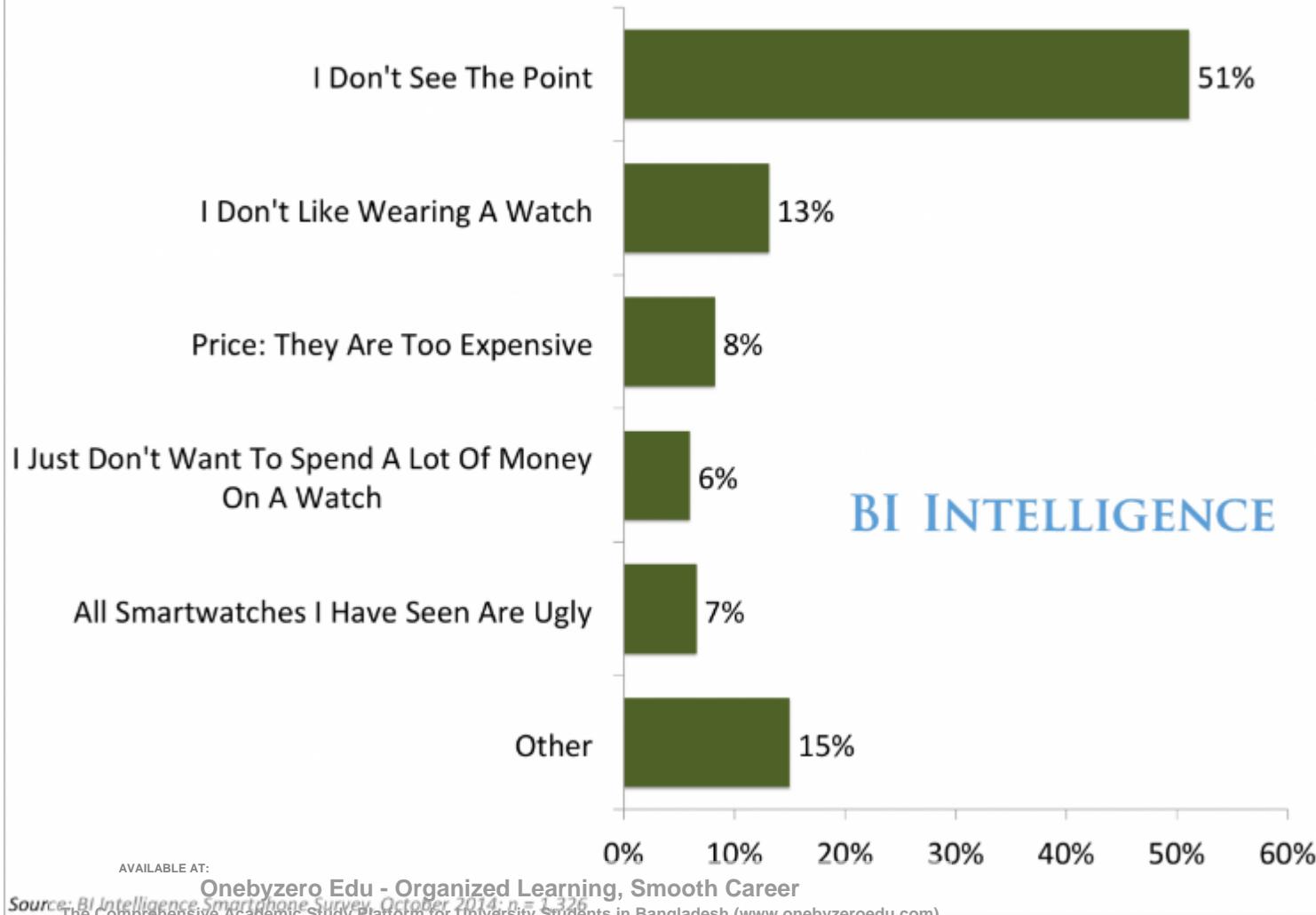
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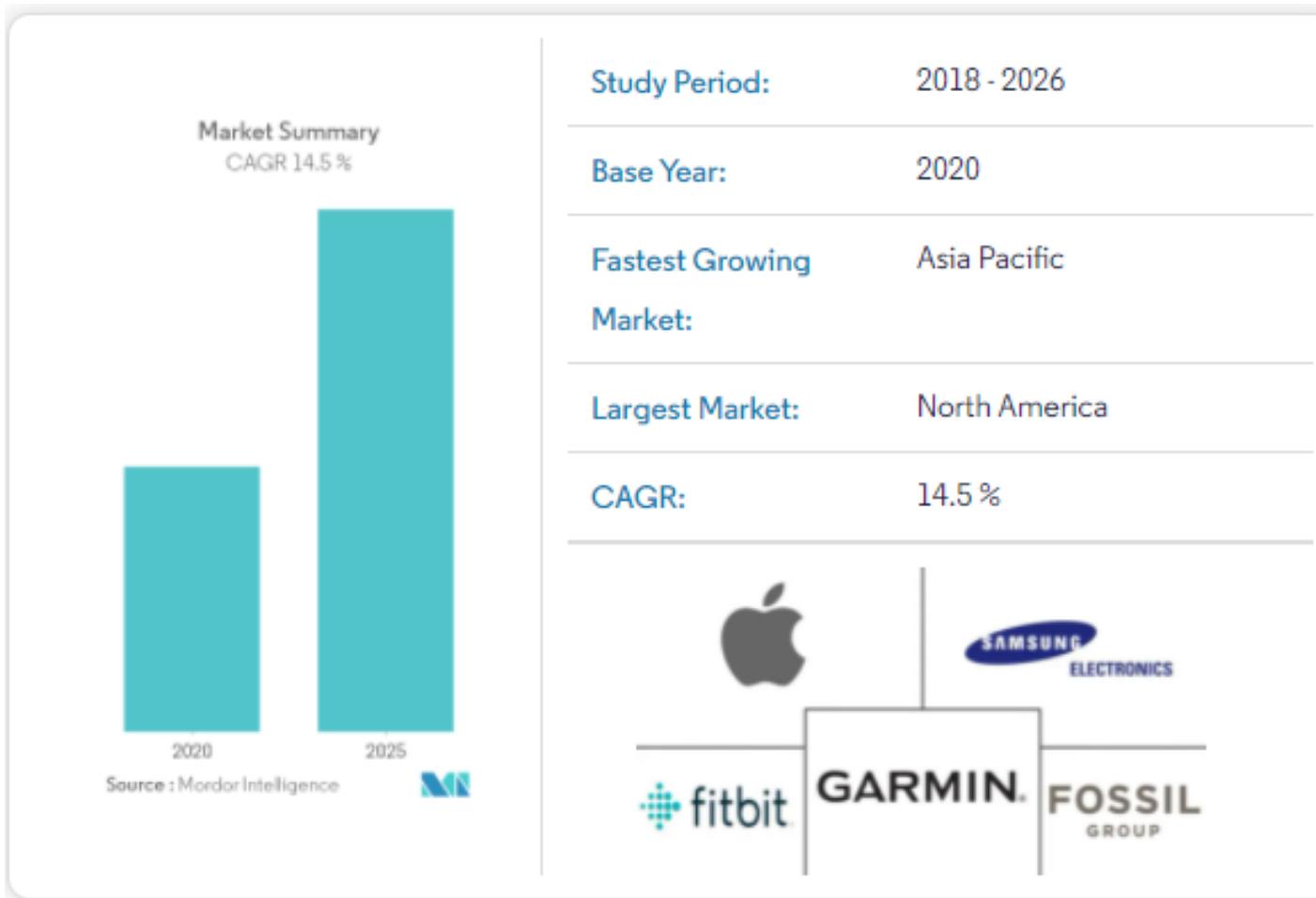
BI INTELLIGENCE

# Trends in Mobile: Smart watches

## Why Aren't You Interested In A Smartwatch?



# Smartwatch Market Size



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# Trends in Mobile: Healthcare

## HEALTHCARE MARKET TRENDS

The web is crucial for healthcare

### VIDEO INSIGHTS

Consumers are skipping the personal trainer and getting fit through YouTube videos.

Health and fitness channel **TONE IT UP** has over **20 MILLION VIDEO VIEWS**

Source: [Youtube.com/user/Toneitupcom](http://Youtube.com/user/Toneitupcom)

### SEARCH INSIGHTS

Health consumers buy more diet and fitness products in the Summer than any other season.

Season	Percentage
Summer	41%
Spring	29%
Winter	22%
Fall	8%

Source: Google/The Modifiers, Health Conscious Consumer Study, September 2013.

### PATH TO PURCHASE

88% of those looking for health information start with **SEARCH ENGINES**.

Source: 2012 Google/Comperem Treatment Study

### SEARCH TRENDS BY DEVICE

Year over year the number of consumers using mobile devices to stay healthy has doubled.

#### HEALTH CARE SERVICES

Device	Q4 2012	Q4 2013
Smartphone	29%	36%
Tablet	7%	8%
Desktop	64%	56%

#### NUTRITION & DIETING

Device	Q4 2012	Q4 2013
Smartphone	29%	37%
Tablet	9%	10%
Desktop	62%	53%

Source: Google Internal Data.

### CONSUMER INSIGHTS

**80%** HOSPITAL ADMINISTRATORS contact a vendor directly after an online search.

Source: Google and HIMSS Analytics, Hospital Decision Makers Study, May 2013

**57%** of **BABY BOOMERS** have searched for healthcare and wellness information online.

Source: Inside Look at Boomer Healthcare Consumers, 2010

**80%** of those looking for weight loss, rated search as **EXTREMELY IMPORTANT** to their decision process.

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### KEY INSIGHTS

When patients see a paid search ad, they take **ACTION...**

Action	Percentage
Conduct searches for more info	26%
Begin the research process	38%
Visit the website of treatment center that was advertised	39%
Consider a treatment center that was advertised	36%

Source: 2012 Google/Comperem Treatment Study

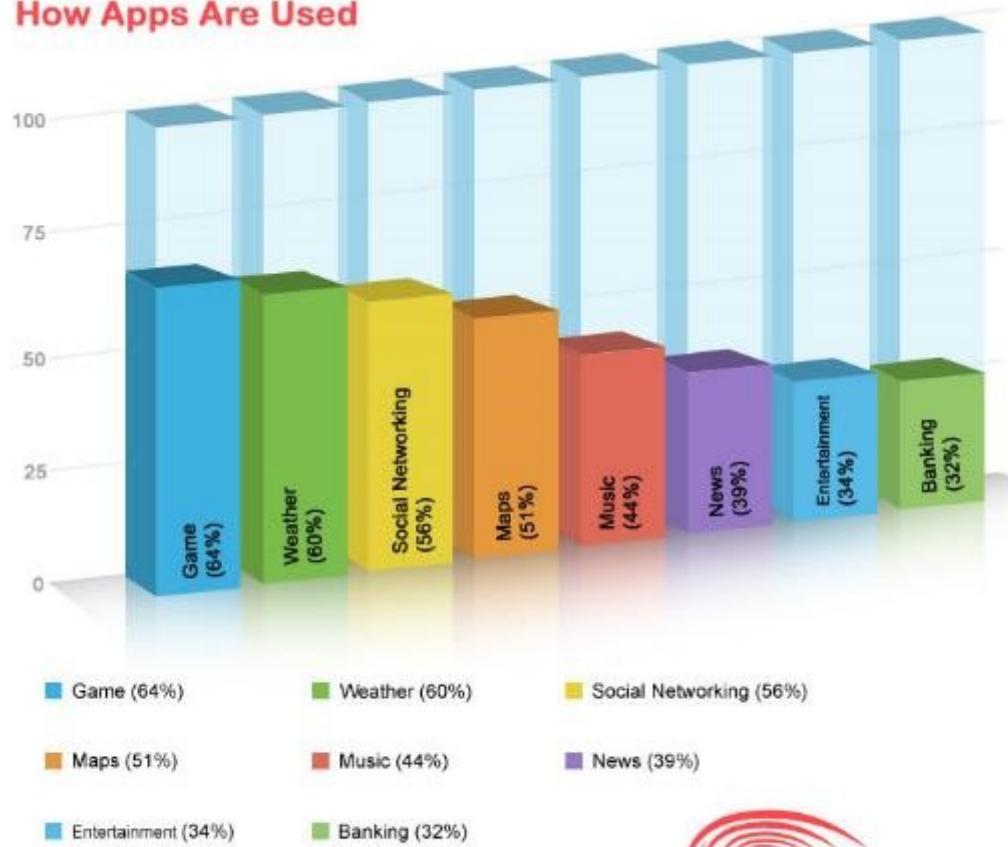
### GOOGLE SOLUTIONS DRIVE RESULTS

Simple and easy to use

Google

# Trends in Mobile: Apps

How Apps Are Used



Source: Nielsen

Website: [www.crispycodes.com](http://www.crispycodes.com) | Email: [info@crispycodes.com](mailto:info@crispycodes.com)

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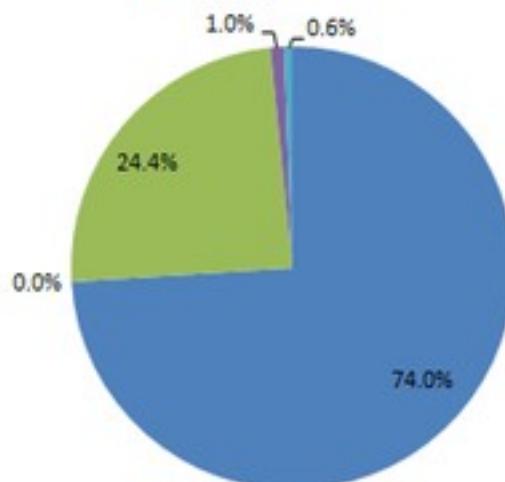
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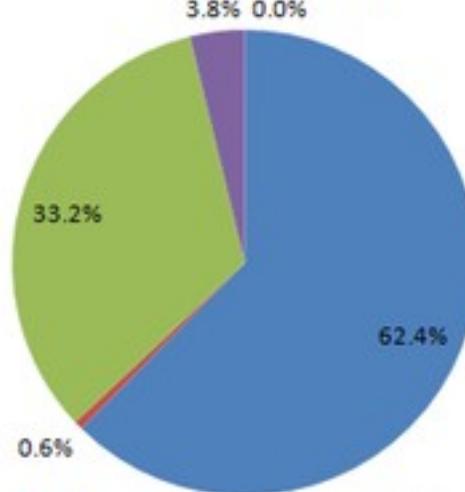
# Trends in Mobile: Smartphone OS

Smartphone Operating System Market Share

China April 2015



USA April 2015



■ Android ■ BlackBerry ■ iOS ■ Windows ■ Other ■ Android ■ BlackBerry ■ iOS ■ Windows ■ Other

Market Realist

Source: Kantar World Panel

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# Trends in Mobile: Apps



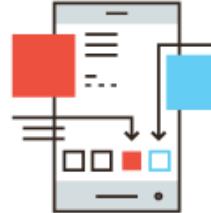
# iOS App Statistics



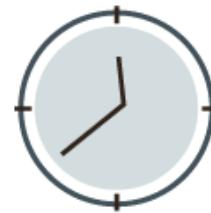
**100**  
**billion**  
apps downloaded  
since 2008



**119**  
apps downloaded  
per iOS user



**1.5 million**  
apps in the  
App Store



**850**  
apps downloaded  
per second

# Trends in Mobile: Students



NEARLY ALL STUDENTS  
TEXT EVERYDAY...

Send texts everyday

YES **94%**    NO **06%**



...MUCH MORE THAN  
MAKE CALLS EVERYDAY.

Make calls everyday

YES **73%**    NO **27%**



TECH ADDICTION? MANY  
STUDENTS EXPERIENCE IT.

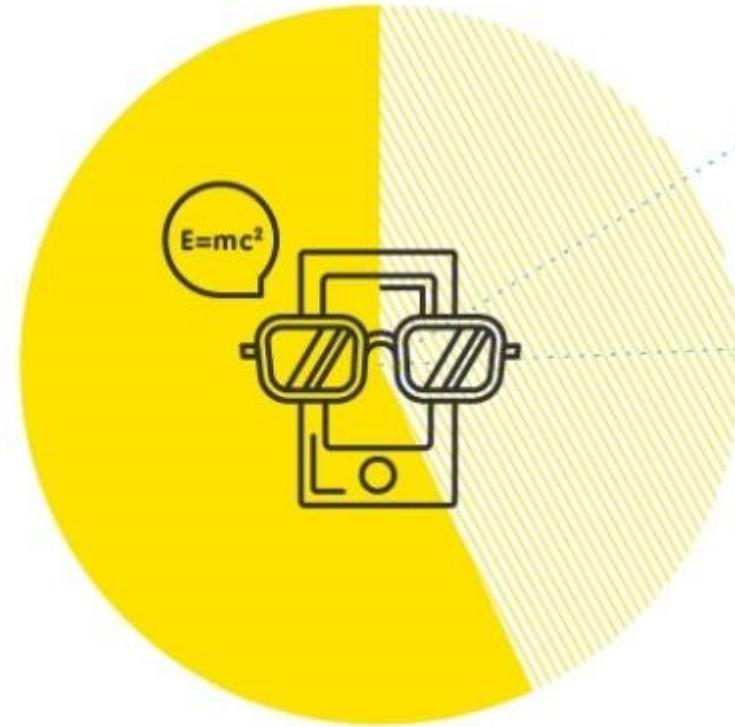
Sometimes feel 'addicted'  
to phone

YES **60%**    NO **40%**

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# Trends in Mobile: Students



A MAJORITY OF STUDENTS IN OUR SURVEY USE SMARTPHONES.

SMARTPHONE: **57%** BASIC: **43%**  
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IPHONE AND ANDROID ARE NECK-AND-NECK FOR THE TOP SPOT

IPHONE	<b>42%</b>
ANDROID	<b>43%</b>
BLACKBERRY	<b>12%</b>
WINDOWS 7	<b>02%</b>

NEARLY ALL SMARTPHONE OWNERS USE THEM FOR SOCIAL NETWORKING...

Use phone for social networking:

YES **97%** NO **03%**



BUT LUCKILY, CHEATING ON A PHONE IS RARE

Has cheated on test with phone

YES **13%** NO **87%**